BAKELITE

REG. U. S. PAT. OFF.

MOLDED

REG. U. S. PAT. OFF.

SEVENTH EDITION

BAKELITE CORPORATION

247 PARK AVE., NEW YORK, N. Y.

Plants at Bound Brook and Bloomfield, N. J.

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BAKELITE CORPORATION OF CANADA, LTD.

165 Dufferin Street, Toronto, Ontario, Canada

FOREWORD

This booklet deals with the subject of Bakelite Molding Materials and their uses, and gives a brief description of the molding process and needed equipment.

Other Bakelite products, such as laminated materials, cast resinoids, cements, varnishes, enamels and lacquers of the "baking type," and oil-soluble phenolic resins for quick-drying finishes, are described in separate booklets, copies of which may be obtained upon request.

TRADE MARK REG. U.S. PAT. OFF.

BAKELITE

The registered trade-marks shown above distinguish materials manufactured by Bakelite Corporation. Under the capital "B" is the numerical sign for infinity, or unlimited quantity. It symbolizes the infinite number of present and future uses of Bakelite Corporation's products.

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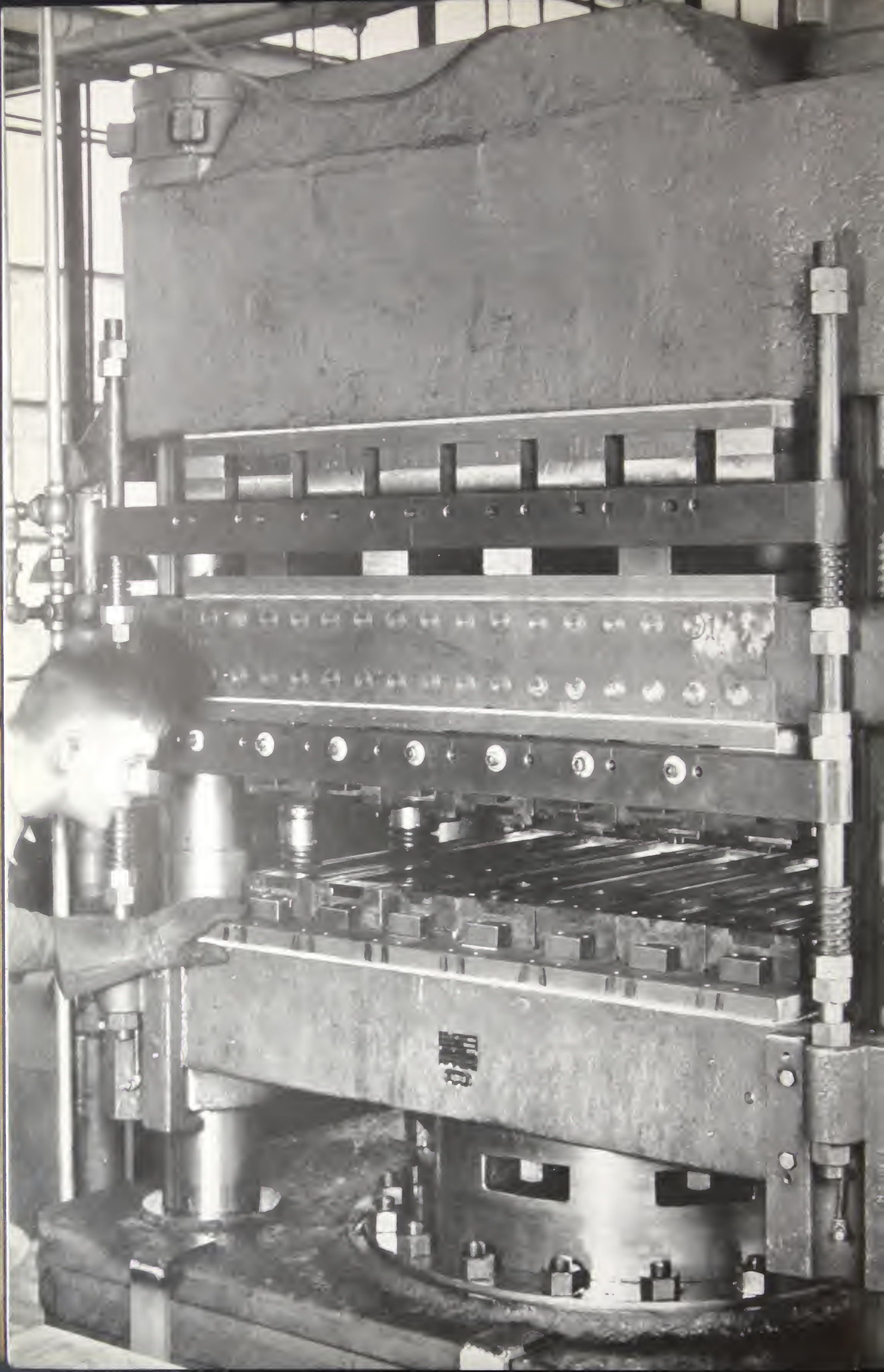


BAKELITE MOLDING MATERIALS

for Electrical, Mechanical and Chemical Uses

This is well termed the day of creative chemistry. It has given us many new and better materials without which modern industry and our present-day standards of living would be impossible.

Among such new and better materials, all products of chemical research, are vulcanized rubber, coal-tar dyes, celluloid, commercial aluminum and its alloys, carborundum, stainless steel, rayon, cellophane, and phenol resinoid plastics, of which Bakelite products were the first and remain the foremost representatives.

Phenol resinoid plastics constitute an American achievement. They were invented, in 1907, by Dr. L. H. Baekeland, after exhaustive research. Doctor Baekeland gave the world an entirely new substance, phenol resinoid, a substance which has found extensive use in nearly every field of industry. It is a significant fact that those who were the first to take advantage of the distinctive qualities of the new plastic materials based on this new substance are today among the largest users of these materials.

Thus they find application in such widely divergent uses as jewelry and dentures, dash pots and grinding wheels, pump valves and timing gears, refrigerator breaker strips and condenser explosion chambers, door knobs and wall panelling, low-loss radio insulation, and radio cabinets, closures for bottles and collapsible tubes, carbon brushes and switchboard insulation, gear shift knobs and distributor heads, lighting insulation and lamp-basing cements, chemically resistant lacquers and water resistant flexible coatings for fabrics.

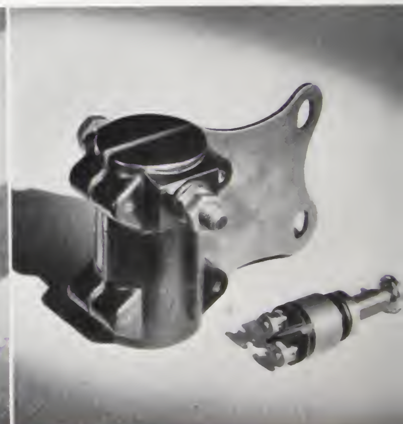
● AUTOMOTIVE PARTS

Distributor head

Ignition coil case

Horn button and switch assembly

Spark plug covers



Case and insulation parts for button starter

What Bakelite Phenolic Resinoid Is

Like most products of creative chemistry, phenol resinoid bears no resemblance to the raw materials from which it is made. Principal among these raw materials are phenol or "carbolic acid," a white crystalline solid, and formaldehyde, a gas, which when dissolved in water is commonly known as formalin. Both are highly reactive substances. Under certain definite, controlled conditions they may be caused to combine chemically, forming a distinctly new and highly useful product, a product which is resin-like but superior in its properties to any natural resin.

In its raw, or primary state, phenol resinoid is quickly softened by moderate heat, and is soluble in certain solvents, notably alcohol. Further heating, however, causes it to harden, after which it cannot again be softened at any temperature. Furthermore, the solvents which served to dissolve it in its primary state now have little or no effect on it. This property of being first fusible and soluble, and then, under the influence of heat, becoming infusible and insoluble—of becoming, in fact, a material of pronounced hardness, strength, and resistance to deteriorating agents generally, has made phenol resinoid outstanding among organic plastic materials. It is called a resinoid to distinguish it from natural resinous substances.

Bakelite resinoid is produced by the Bakelite Corporation, employing processes perfected through a quarter century of research and manufacturing experience—BAKELITE being the trade-mark employed exclusively to designate the products of the Bakelite Corporation.

Cast Bakelite resinoid, which is produced in a wide variety of colors and used extensively in the manufacture of pipe stems, parasol handles, knobs, beads, bracelets and similar articles, is not fabricated by a pressure molding process, but is cast roughly to shape and turned or otherwise machined to finished form. Such manufacture is a special art, entirely distinct from that of plastic molding. Leaflets describing these so-called transparent materials may be had on request.

Attachment plug with cartridge fuses

● ELECTRICAL PARTS

Fuse plug

Panelboard units

Circuit breaker

Binocular

Barometer case

Parts for oil well drilling equipment

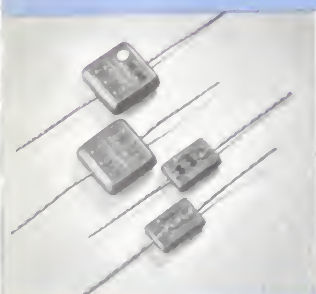
● MECHANICAL PARTS

Typewriter top plate

Radio cabinets

Remote control housing for automobile radio

Photo-electric cell case



Condensers

Transmitting condenser housing

Coil forms

● RADIO PARTS

The Molding Materials

Bakelite molding materials are prepared from primary Bakelite resinoid and various so-called filling agents. The all-important ingredient is the resinoid itself, which imparts to the molding materials the property of quickly hardening in the heat which first renders them plastic, and which, as bonding and surfacing substance, imparts to the molded products most of their distinctive properties.

The use of the filling materials, which include cellulose, asbestos, fabric, paper is for the added value given by the special properties of these materials—better molding qualities, greater toughness and strength, and, in the case of mineral fillers, an increased degree of water- and heat-resistance. In every case the hardened Bakelite resinoid remains unchanged in its many superior properties.

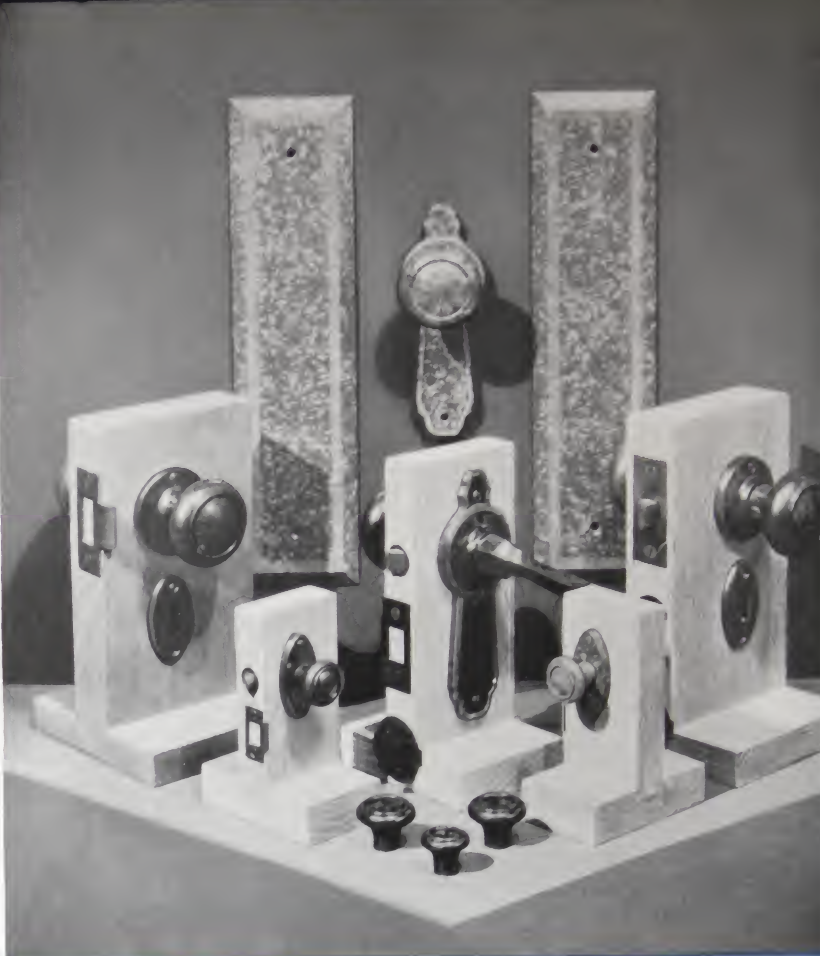
The Bakelite Molding Materials are prepared in either powder or sheet form and are supplied to the trade ready for use. They are made according to well-established formulas, and under close laboratory control. In specifying "Bakelite" the purchaser gets not merely a name but materials of definite and uniform quality.

Five General Classes

The molding materials are of five general classes:

Cellulose-filled Materials — Mineral-filled Materials
Molding Sheet — Impact Materials
Special Materials

There are a number of materials in each of these classes differing in their characteristics as may be necessary to meet the requirements of specific applications. The five classes are described briefly in the following paragraphs. A complete list will be sent upon request.



Door knobs, escutcheon plates, drawer pulls and push plates

● HARDWARE

Utensil and tool handles and furniture fitments

Cellulose-Filled Materials

The following figures represent high and low values for molded materials of the cellulose group:

MOLDED CELLULOSE MATERIALS

1. Specific Gravity	1.34 to 1.52
2. Weight per cubic inch	0.78 to 0.88 oz. (22. to 25. gms.)
3. Tensile Strength	6,000 to 11,000 lbs. per sq. in.
4. Compressive Strength	25,000 to 36,000 lbs. per sq. in.
5. Impact Strength	
A.S.T.M. (New)	.24 to .560 ft. lbs. per inch of notch
A.S.T.M. (Old) Energy to break test piece	0.12 to .280 ft. lbs.
or	
$\left(\frac{\text{Energy to break test piece}}{bd^2\ *}\right) =$	1.5 to 3.5 ft. lbs. per in. sq.
6. Flexural Strength (transverse)	10,000 to 20,000 lbs. per sq. in.
7. Modulus of Elasticity (by flexure)	1.0 to 2.5 x 10^6 lbs. per sq. in.
8. Distortion under heat (2½ Kgm. load)	120°C. to 130°C.
9. Specific Heat	.3 to .4 gm. calories per gm. per °C.
10. Thermal Conductivity	0.0004 to 0.0006 calories per sq. cm. per second per °C. per cm.
11. Coefficient of Heat Expansion	30 to 40 x 10^{-6} per °C.
12. Dielectric Strength (Instantaneous 60 cycles)	300 to 500 volts per mil
(Step 60 cycles)	250 to 400 volts per mil
13. Volume Resistivity (at 30°C.)	10^4 to 10^6 megohm-centimeters
14. Power Factor (10^3 cycles)	.04 to .15 (4.0% to 15.%) **
(10^6 cycles)	.035 to .10 (3.5% to 10.%) **
15. Dielectric Constant (10^3 cycles)	4.5 to 8
(10^6 cycles)	4.5 to 8
16. Water Absorption (Disc 2″ diameter x ⅛″ thick—24 hrs.)	0.2%—0.6%
Water Absorption (Disc 2″ diameter x ⅛″ thick—144 hrs.)	0.6%—2.0%
17. Standard Colors	Black and Brown
18. Colors made to order	A wide variety

Values given under 3 to 15, inclusive, are from A.S.T.M. Standard Tests.
* b=width; d=thickness (measured in the direction of force application).
** The molding material should be protected against absorption of moisture from the air if these values for power factor are to be maintained. Proper preheating before molding gives improved electrical properties. For the best values in power factor we recommend our Low Loss material described on page 27.

Cellulose-filled materials are supplied mainly in the form of dry, granular powders. They readily soften and flux under suitable heat and pressure, which permits their being formed in hardened steel molds, into a limitless variety of forms. The cellulose-filled materials are employed for such commonly known articles as radio tube bases, tube and bottle closures, switch plates, wall plugs, door knobs, telephone receiver sets, buttons, pencil barrels, and many others.

Globe with molded base

Notion box

Perpetual calendar

Handbag watch case

● PREMIUMS and NOVELTIES

Cocktail shaker with molded fitments

These powder materials compress in the molding process to about 40 per cent of their original volume. That is, the volume of the molding powder is about 2½ times the volume of the molded product. When preformed before molding (see page 41) their volume is about 1½ times that of the molded product.

Molded cellulose-filled materials are used principally in applications requiring lightness, superior finish, and mechanical strength together with good electrical properties.

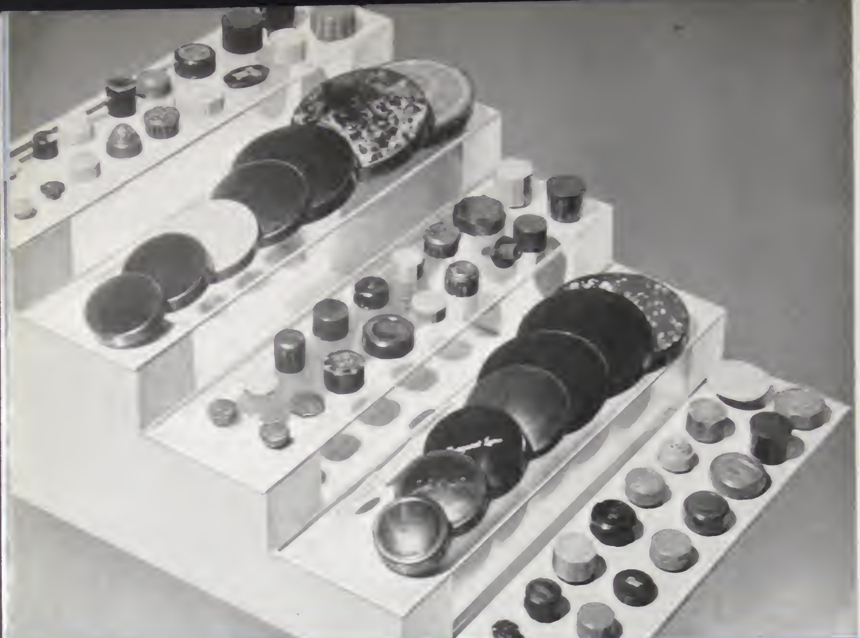
COLORED MATERIALS

These materials are produced in stock colors, black, brown and several attractive mottle combinations. A line of bright colors is available on a made-to-order basis. Upon demand, special colors to match samples are obtainable.

Molding Sheet

Bakelite molding material in sheet form is made in one standard size approximately 18 inches long, 40 inches wide, and 3/16 inches thick. Special sizes and thicknesses, within a narrow range, may be obtained at a slightly additional cost. Molding sheet is hard and brittle when cold, but as a preliminary to molding can be softened in a short time, preferably in an oven at 180° to 200°F. or, as a last resort, on a hot plate, placing an insulating material, such as cotton duck, between the sheet and the hot plate. In this softened condition the sheet may be cut, or, in some instances, punched into suitable form for charging the mold.

Bakelite molding sheet was developed for use in overflow or flash molds, where there are no facilities for tableting; also for molding complicated forms which require a material that is more plastic than the



Group of jar covers, tube and bottle caps

● PACKAGES and CLOSURES

Dual-use packages

Physician's carrying cases

Closures for liquor bottles

Cabinet for binding fabrics

● DISPLAY DEVICES

Glove-measuring device with molded case

Base for perfume bottle

Perfume display stand

Ash tray

Smokers' pipes

Handles on kitchen utensils

Heater plug

● HEAT-RESISTANT MATERIALS

standard powder materials. It has, in general, the same physical characteristics as the cellulose-filled molding powder, and, in molding, requires the same pressure, time of cure, etc. However, unless exceptional molding plasticity is required, it is not recommended, since it is slightly inferior to the powder materials in mechanical strength.

An interesting application of molding sheet is the production of matrices for rubber printing plates, as employed in the bag industry.

Mineral-Filled Materials

The following table gives the range of properties characterizing this group:

MOLDED MINERAL-FILLED MATERIALS

1. Specific Gravity	1.8 to 2.0
2. Weight per cubic inch	1.1 to 1.2 oz. or 31.2 gms. to 34.5 gms.
3. Tensile Strength	5,000 to 10,000 lbs./sq. in.
4. Compressive Strength	18,000 to 36,000 lbs./sq. in.
5. Impact Strength	
A.S.T.M. (New)	0.24 to 0.72 ft. lbs. per inch of notch
A.S.T.M. (Old) Energy to break test piece	0.12 to 0.36 ft. lbs.
or	
$\left(\frac{\text{Energy to break test piece}}{bd^2\,*}\right) =$	1.5 to 4.5 ft. lbs. per in. sq.
6. Flexural Strength (transverse)	8,000 to 20,000 lbs./sq. in.
7. Modulus of Elasticity (by flexure)	1.0 to 2.5 x 10^6 lbs./sq. in.
8. Distortion under heat (2½ Kgm. load)	120° to 135°C.
9. Specific Heat	.25 to .35 gm. calories per gm. per °C.
10. Thermal Conductivity	0.0008 to 0.0020 calories/sq. cm. per second per °C. per cm.
11. Coefficient of Heat Expansion	20 to 30 x 10^{-6} per °C.
12. Dielectric Strength (Instantaneous 60 cycles)	200 to 400 volts per mil
(Step 60 cycles)	150 to 300 volts per mil
13. Volume Resistivity (at 30°C.)	10^3 to 10^5 megohm-cms.
14. Power Factor (10^3 cycles)	.10 up (10.% up)
(10^6 cycles)	.05 to .10 (5.% to 10.%)
15. Dielectric Constant (10^3 cycles)	4.5 to 20
(10^6 cycles)	4.5 to 20
16. Water Absorption (Disc 2" diameter x ⅛" thick—24 hrs.)	.01 to .3%
Water Absorption (Disc 2" diameter x ⅛" thick—144 hrs.)	.10 to 1.0%
17. Standard Colors	Black and Brown
18. Colors made to order	A limited variety

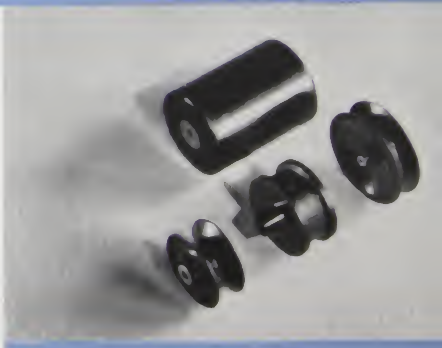
Values 3 to 15, inclusive, represent A.S.T.M. Standard Tests.
* b=width; d=thickness (measured in the direction of force application).

Rayon spinning bucket

● TEXTILE PARTS

Button breaker roll

Thread winding parts



Spools

The mineral-filled materials are somewhat more difficult to process in the molding and tableting operations than the cellulose materials and their molded products are less easily machined. They are employed when higher heat-resistance and better water-resistance are desired than could be obtained with the standard cellulose-filled materials. Also they have a lower coefficient of heat expansion and lower shrinkage in the molding operation, which in some instances is an advantage.

A number of these materials have been developed, each especially suited to a particular type of service. Applications include molded commutators, heater connectors, outdoor insulation, handles of cooking utensils, and the like.

Impact Materials

The incorporation of primary resinoid with cellulose, as in the production of the standard cellulose-filled materials, provides good molding quality and improved impact resistance in the molded product. Incorporation of the primary resinoid with paper or fabric, as in the production of the so-called Laminated materials (described in a separate booklet), gives a product that may be hot pressed into plates or other very simple forms only, but which has greatly increased resistance to impact.

The impact molding materials bridge the gap between these two extremes. There is a whole series of these materials, providing impact strengths of 5 to 6, 9 to 11, 11 to 13, 18 to 20, and 25 to 30 ft. lbs. for an inch square, respectively. The first in the series gives molded products having impact strengths about three times that of standard cellulose-filled molded products, and with but little sacrifice of molding or preforming qualities. The last in the series gives molded products having 10 or more times the impact strength of the standard cellulose-

● IMPACT MATERIALS

Vibrator case

Fishing reel

Electrical connector

Oil well drilling equipme

Ledger covers

Card holder

filled materials, but must be molded under a pressure of about 5,000 pounds per square inch and can be preformed in a hand press only, instead of an ordinary tableting machine.

Thus the purpose of these materials of intermediate impact strengths is that of providing molded objects having impact strength adequate for a given use without unnecessary sacrifice of molding and preforming qualities.

The properties of objects molded from the material of the series having the highest impact strength are given in the following table. The molded products of the other impact materials differ mainly in the possession of lower impact strengths and better preforming and molding qualities.

MOLDED HIGH-IMPACT MATERIAL

1. Specific Gravity	1.37—1.40
2. Weight per cubic inch	.79 to .81 oz. (22.4 to 22.9 gms.)
3. Tensile Strength	6800.—7200 lbs. per sq. in.
4. Compressive Strength	20,000—30,000 lbs. per sq. in.
5. Impact Strength	
A.S.T.M. (New)	4.00 to 4.80 ft. lbs. per in. of notch
A.S.T.M. (Old) Energy to break test piece	2.00 to 2.4 ft. lbs.
or $\left(\frac{\text{Energy to break test piece}}{bd^2 *}\right) =$	25.0 to 30. ft. lbs. per in. sq.
6. Flexural Strength (transverse)	10,000 to 13,000 lbs. per sq. in.
7. Modulus of Elasticity (by flexure)	.70—1.00 x 10^6 lbs. per sq. in.
8. Distortion under heat (2½ Kgm. load)	130°C.
9. Specific Heat	.30 to .35 calories per gm. per °C.
10. Thermal Conductivity	0.0003 to 0.0007 Cal./sq. cm. per sec. per °C. per cm.
11. Coefficient of Heat Expansion	20 x 30 x 10^{-6} per °C.
12. Dielectric Strength (Instantaneous 60 cycles)	300 to 400 volts per mil.
(Step 60 cycles)	200 to 300 volts per mil.
13. Volume Resistivity (at 30°C.)	.5 to 1.0 x 10^5 megohm centimeters
14. Power Factor (10^3 cycles)	.08 to .20 (8.% to 20.%)
(10^6 cycles)	.05 to .10 (5.% to 10.%)
15. Dielectric Constant (10^3 cycles)	4.5 to 6.0
(10^6 cycles)	4.5 to 6.0
16. Water Absorption (Disc 2″ diameter x ⅛″ thick—24 hrs.)	about 1.0%
Water Absorption (Disc 2″ diameter x ⅛″ thick—144 hrs.)	about 3.3%
17. Standard Colors	Black, brown and tan
18. Colors made to order	A limited range

Values 3 to 15, inclusive, represent A.S.T.M. Standard Tests.
* b=width; d=thickness (measured in the direction of force application).

Nozzle and splash plate for cooling tower made with chemical-resistant material

● SPECIAL MATERIALS

Ice cream compartment cover made with all-resin surfacing material

Rheostat insulated with low loss material

Special Materials

Uncommonly exacting service conditions have called forth special materials to meet them.

Thus there have been developed materials of exceptional water-resistance. Discs molded from one of these materials, after immersion in water for a year, show a diameter increase of less than 0.001″ per inch and no surface effect. In boiling water for a year the increase is only about 0.003″ per inch, and the surface effect very slight.

Still another type of material shows only slight surface effect from immersion for twenty-four hours in boiling 5 per cent caustic soda solution.

A special material of the mineral-filled type has been developed for use in molded ash trays. Here there is exceptional heat-resistance at the surface of the molded tray. Such trays do not blister.

There is a "low loss" material especially useful in radio condenser forms and housings. It has a low power factor (10^3 1.6 per cent, 10^6 cycles 0.75 per cent) which suffers little change after a day's immersion in water. This material has a high volume resistivity (above 10^8 megohms per cubic centimeter) which drops off much less with rise in temperature than in the case of ordinary materials.

A special material developed for magneto insulation is finding use in aircraft ignition, where a material of high insulation resistance, high dielectric strength, and improved resistance to carbonization under a low amperage arc is necessary. When molded this material is less rigid than the regular materials. It has been found of advantage for use when molding a relatively thin wall of material around a large metal insert.

Of interest is a special material which has marked opacity to the X-ray, and which finds use in the manufacture of X-ray shields.

Magneto part made from arc-resistant material

X-Ray tube guards made of special insulation material

Water-resistant water meter di[illegible]

Caster made with graphite-fill[illegible] material

● SPECIAL MATERIALS

A Unique Combination of Superior Properties

Not only are Bakelite molded products exceptional in their strength, hardness, and electrical properties, but they are also highly resistant to heat. The cellulose-filled products, for instance, withstand for hours, without distortion or charring, temperatures up to 150°C. (320°F.). The tensile and impact strengths of certain of the mineral-filled products are unaffected for short periods by temperatures up to 235°C. (455°F.). Again, not only are these products highly resistant to water, but also to oil, to the common solvents, to mild alkalies, and to organic and dilute mineral acids. They are disintegrated, on the other hand, by strong sulphuric or nitric acid, or strong alkalies.

The electrical industry early recognized the value of Bakelite products as the solution to numerous insulation problems.

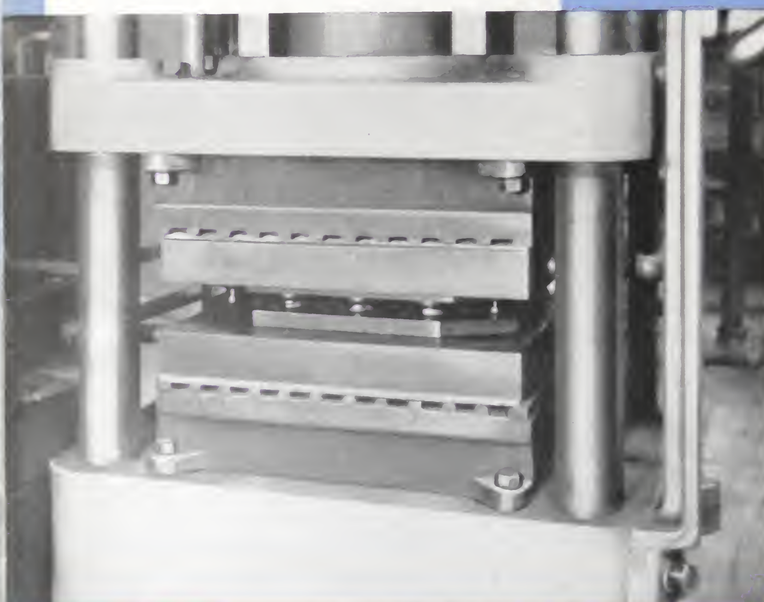
The automotive industry selected the molding material for ignition parts, not alone for its good electrical properties, but because of its high resistance to heat, water and oils, and the accuracy and economy with which it can be fabricated. These characteristics have long been sought in structural materials generally; thus it is that we find Bakelite molded products widely employed for purely mechanical purposes, replacing metals, woods, and a number of other natural materials. The high impact materials are especially adapted for parts which must withstand rough handling, such as vibrator cases, fishing reels, handles, and ledger covers.

Because of their high corrosion resistance, these impact materials are also used for parts of apparatus in the chemical industry, such as molded fittings for pipe lines conveying acids that would attack and destroy iron or brass.

It is this unique combination of superior properties that accounts for the many and varied ways in which Bakelite molded products are rendering valuable service.

THE MOLDING PROCESS

Loading preforms in mold



Position of press during molding operation

Removing molded parts

The finished piece

Standard Tests for Molded Products

Engineers have long recognized the need of standard methods for testing molded products. Without agreement on methods, agreement in results is not to be expected.

It is well known, for instance, that, depending upon the method employed in making the test, a wide range of values may be obtained for the dielectric strength of any material. For one thing the voltage required to break down a given material is not proportional to the thickness. With Bakelite molded products it varies approximately as the square root of the thickness. It would be entirely incorrect, therefore, to assume that by doubling the thickness of a piece of insulation, the break-down voltage would also be doubled. Conversely, it would not be proportionately reduced if the thickness were cut to one-half. The thickness of the piece tested is therefore a highly important factor and should always be stated when giving figures for dielectric strength. Also, the shape of the electrodes used and the rate at which the applied voltage is increased materially affect the value obtained.

Similarly the values obtained for other electrical properties depend on the conditions of test.

So also with mechanical tests; such, for instance, as the impact or shock-resistance test. This may be defined as the energy in foot pounds required to break a specimen having a cross-section an inch square; that is a square that measures an inch on a side, not a square inch of any shape of section.

To meet the need for methods of testing that would be acceptable to engineers and manufacturers generally, the American Society for Testing Materials some years ago appointed a committee known as "Committee D-9" composed of engineers from some of the leading electrical companies and the manufacturers of insulating materials, for the purpose of working out standardized methods for such tests.*

As a result of the intelligent labors of this committee, "A.S.T.M." standards are today accepted generally in the electrical world.

* For a full description of these tests, see leaflet, "Standard Methods of Testing Molded Insulating Materials," issued by the American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pennsylvania.

● MOLDS

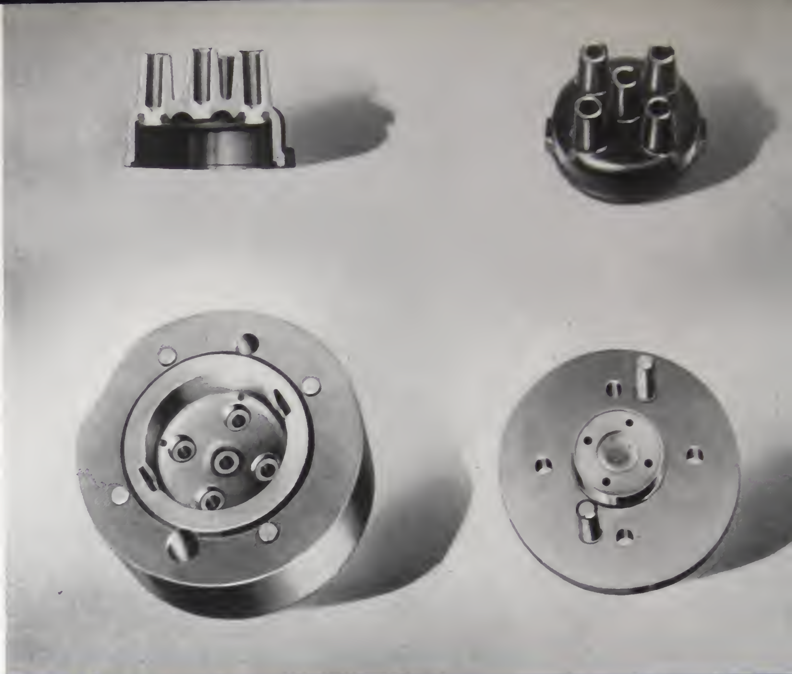


Figure No. 1. "Overflow" mold for automobile distributor head and finished part

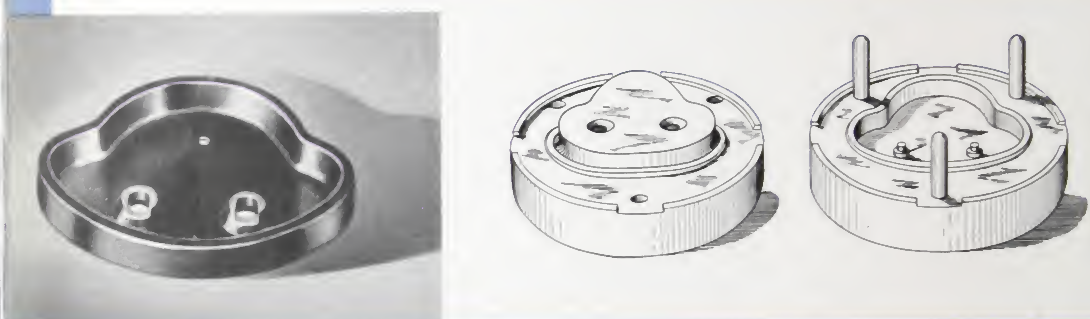


Figure No. 2. "Overflow" mold for electric instrument cover and finished part

Figure No. 3. "Positive" mold for instrument case and finished part

The Molding Process

Molding is performed in hardened steel molds, which are subjected simultaneously to heat and pressure in suitable presses. As regularly carried out, a weighed quantity of molding powder, or a preformed tablet of compressed powder of suitable weight, is put into the lower half of a heated mold. A powerful press compresses the material as it closes the mold. A short period later the pressure is released, the mold is opened, and there emerges a finished product, formed to the exact shape of the mold—complete and ready for use, except for the removal of the thin mold fin.

Under heat and pressure, a modern miracle has taken place. The fusible material has first fluxed, completely filling the mold; then has hardened, never to soften again. The material has been transformed into a homogeneous solid mass as the result of pressure and a chemical change induced by heat.

The molds may be heated directly as by the circulation of steam through channels provided in them, or indirectly by heating the platens of the press. For the standard cellulose-filled materials molding temperatures range from 140°C. (285°F.) to 165°C. (330°F.), depending upon the material used and the design of the object molded. In practice these temperatures correspond to steam pressures of 100 to 150 lbs. depending on whether the molds are directly channeled or get their heat indirectly from the platens of the press.

The molding time varies with temperature and pressure, character and excess of material used, and thickness of the molded object. The modern practice of discharging the mold hot has greatly speeded up the molding process, so that today, employing a rapid-curing material, the complete molding cycle for a thin-walled object (say 1/16″ thick) may be as low as a minute or less. Increase of thickness calls for more than proportionate increase in molding time. Employing standard materials the molding cycle for objects of average thickness (say 1/8″

Figure No. 4. Molded tubing produced in five-cavity "overflow" mold

● MOLDS

Figure No. 5. Nine-cavity "overflow" mold for cigar lighter case

to 3/16″) is from two to three minutes. Many small objects of such thickness are molded in shorter time.

Illustrations of the molding operation are shown on page 30.

Fidelity of reproduction characterizes all Bakelite molding. Each piece leaves the mold accurate in all its dimensions and mirrors faithfully the lustre or special characteristics of the mold surface. Letters and graduations are produced in the molding operation as sharply as though engraved.

The speed with which this accuracy of reproduction and this fine finish can be obtained, and the readiness with which inserts of all kinds can be securely imbedded during the molding process, make Bakelite molding materials peculiarly suited to quantity-production. Expensive assembling and finishing operations are thus eliminated and manufacturing costs proportionately reduced.

The molded articles can be drilled, tapped or otherwise machined when necessary, but as a general rule such requirements can be provided for in the mold. Even threads of great strength and accuracy can be molded in the material. In all cases the molded product retains its form permanently and does not deteriorate with age.

The Molds

Hardened steel molds are necessary to withstand the high molding pressures employed. Such molds are relatively expensive and ordinarily do not justify their cost unless the number of pieces to be molded is large. Obviously sample pieces cannot be produced without first making a mold for the purpose.

Broadly speaking, there are two primary types of molds used in Bakelite molding. They are known respectively as "overflow" (or "flash") and "positive" molds.

The "overflow" mold (Figures 1 and 2) is made so that the upper

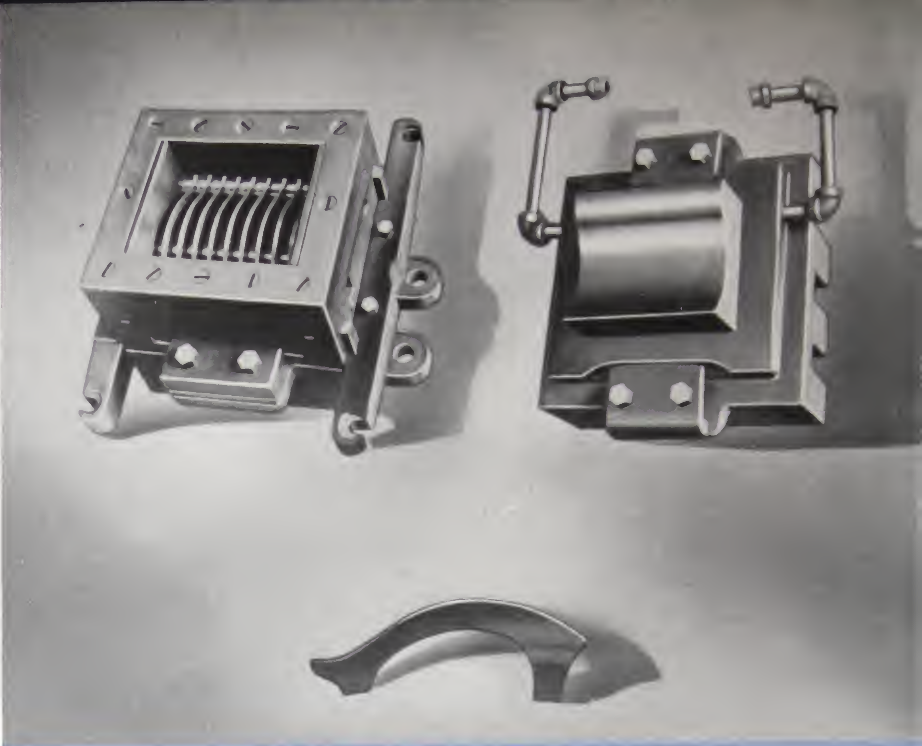


Figure No. 6. Ten-impression "positive" mold for percolator handles

● MOLDS

Figure No. 7. Ten-cavity "overflow" mold for radio knobs

and lower portions rest one on the other as they are brought together under pressure. The mold charge may be either a suitable preformed tablet, a proper quantity of molding sheet, or, if the mold is sufficiently deep compared to the size of the piece to be molded, the proper weighed or measured quantity of molding powder. It is not necessary that the weight of the charge be exact, but a slight excess must be assured, this excess material, sometimes called the "flash," being squeezed out as the edges of the mold come together.

In the "positive" mold (Figure 3), the top force or plunger telescopes within the lower portion of the mold. Powder material is generally used in molds of this type. Careful weighing or measuring of the mold charge is required here, as there is no provision for excess "flash" or overflow. The molds, therefore, must be made of sufficient depth to hold the charge. A powder charge of cellulose material compresses to about 40 per cent of its initial volume.

The two molds shown are very simple forms, but serve to illustrate the different types. Molds are often of complicated design and comprise many separate parts. The more simple the design the less will be the mold cost and the larger the output per mold per day.

Cuts of various types of molds and the pieces produced in them are shown on pages 32, 34, 36 and 44.

Machining

For machining Bakelite molded products diamond cutters give the best results. "Stellite" and chrome-tungsten-steel alloy cutters also give good service.

Tools for machining Bakelite molded should be similar to those used for working brass (thus ). These permit a scraping action rather than a cutting action and are better than tools used for machining steel (shaped thus ).

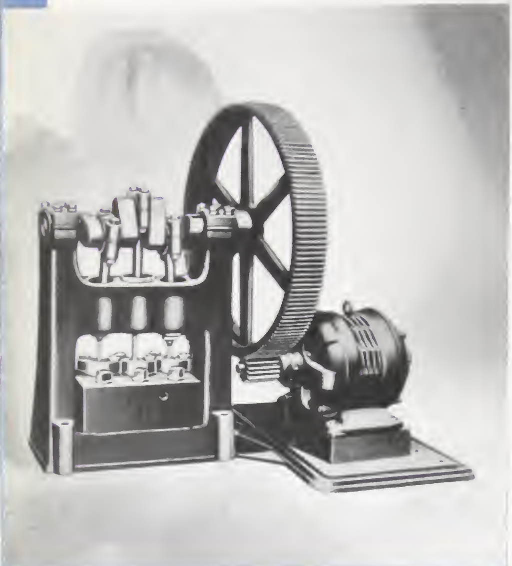


Figure No. 9. High-pressure pump

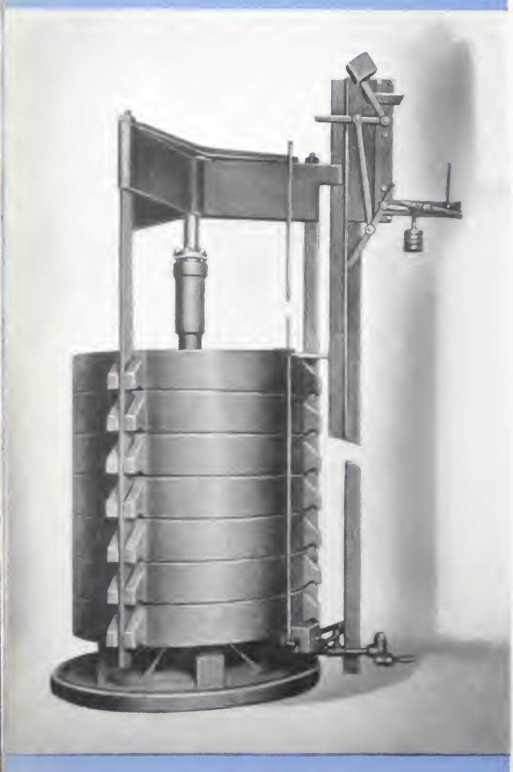


Figure No. 8. Accumulator

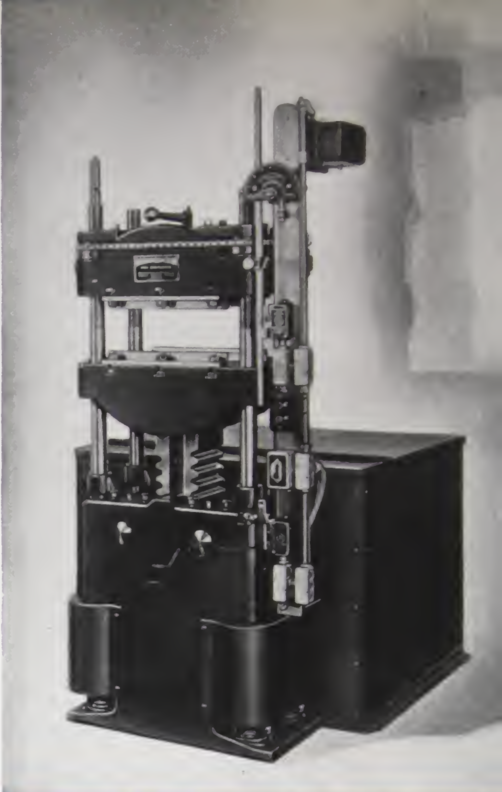


Figure No. 10. Electro-draulic press

Figure No. 11. Tilting head press

● PRESSES AND EQUIPMENT

Several manufacturers are now making drills especially designed for drilling Bakelite molded parts. These drills are made with an extra clearance on the edge of the flutes, to reduce friction and prevent overheating. A drill speed of 3,000 r.p.m. should be used for small diameters.

It is well to determine the number of holes that can be drilled in pieces of a given type before the drill becomes dull. Instructions can then be given the operator to change drills at this point. Avoid excessive pressure when forcing the drill into the material as this tends to heat the drill and destroy the cutting edge.

Such approved machining practice prevents rejects and greatly increases the life of the tools.

The Presses

Presses are of two general classes, hydraulic and mechanical. They are usually heated by steam. Of each class there are two types, the "Hot Plate" and the "Semi-Automatic." Various designs of such presses and the accessory apparatus used with them are illustrated herein. Figures 17 and 18 show hot plate presses.

Removable, or "hand," molds are used in presses of this type. In regular practice the charged molds are subjected to a "curing" period in the hot press. The molded pieces are then ejected hot and left to cool. Occasionally, when an exceptionally fine surface finish or a "close tolerance" is desired, the molds are cooled. This is accomplished either in the molding press or by removing the molds from the press and placing them in a special cooling press. (See Figure 16.) They are then taken to the work bench to be unloaded and recharged.

Two different designs of semi-automatic presses, designated, respectively, as "Tilting Head," and "Retracting Ram" presses, are shown in Figures 11 and 15. While varying more or less in design they are alike in the respect that the molds can be clamped rigidly in place and do

● PREFORMING MACHINES

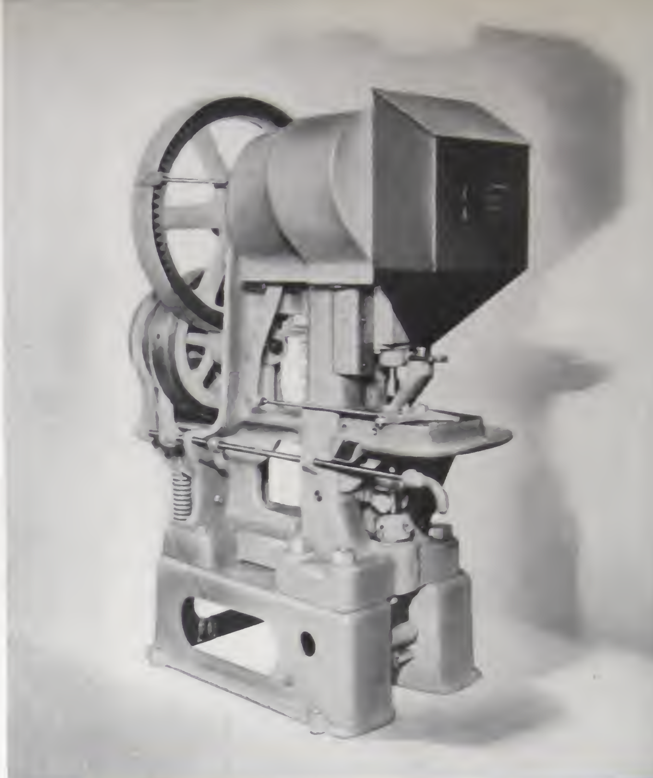


Figure No. 12. Preforming machine

Figure No. 13. Rotary preforming press

Figure No. 14. Preforms, metal inserts, and parts molded from them

not have to be handled by the operator. The molds for presses of this type are made with channels through which steam or cold water may be circulated alternately. The molded pieces are automatically ejected with the opening of the press.

The choice of press to be employed is determined largely by the size and shape of the pieces to be molded, and the number of pieces required.

An "accumulator" and a high pressure pump of the types shown in Figures 8 and 9 are used for supplying hydraulic pressure. Special pressure regulators also are employed.

There are also presses that are closed mechanically. Such a press is shown in Figure 10. Platens are sometimes heated electrically.

Preforming

The practice of "preforming" or compressing the charge into a tablet is now recognized as an advantageous step in the molding process and is very generally employed.

The operation consists of cold-pressing the molding powder into a compact mass of proper form and weight. In form, the tablet should follow roughly the contour of the mold. For preforming cellulose materials a pressure of 4,000 to 8,000 lbs. is required; for impact materials, 6,000 to 10,000 lbs.

A heavy type of tableting machine especially designed for the purpose will preform several thousand tablets a day. (See Figures 12 and 13.)

While preforming involves an extra operation, it is a cleaner and more convenient method than weighing the charge and has the advantage of eliminating waste and of speeding up and simplifying the molding operation, thus increasing the daily output per mold and insuring a more homogeneous molded piece.

Figure 14 illustrates types of tablets, inserts and molded pieces produced from them.

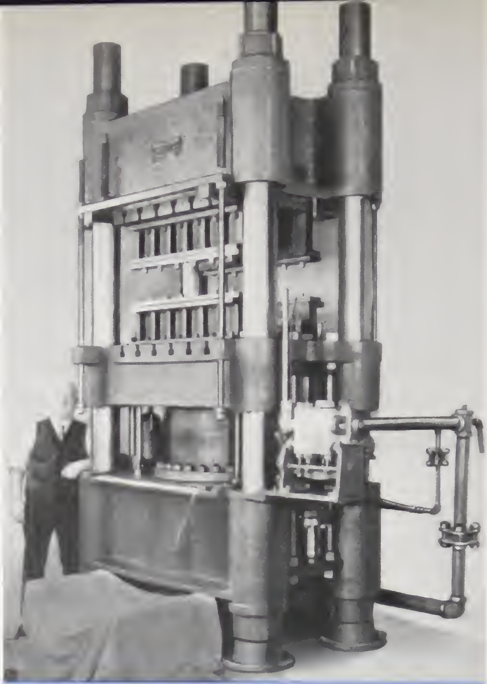


Figure No. 15. Large semi-automatic molding press

Figure No. 16. Chilling press

● PRESSES

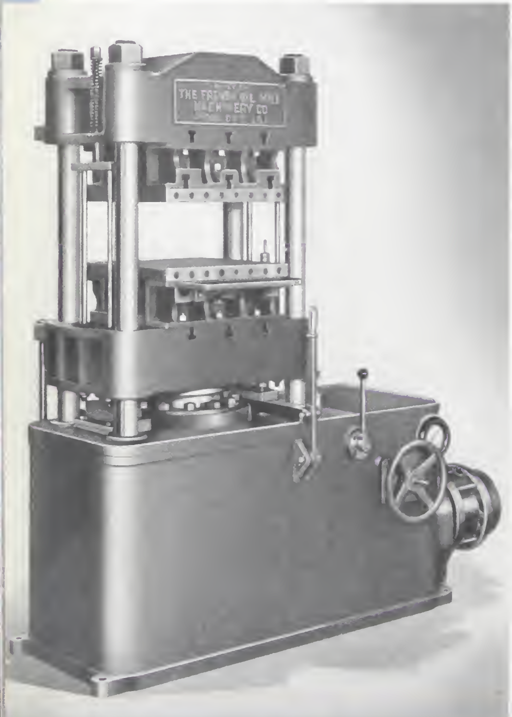


Figure No. 17. Complete molding unit

Figure No. 18. Hot plate press

Mold Designs That Should Be Avoided

The following drawings illustrate, in section, designs of molded parts that involve complicated and expensive molds.

Occasionally one or more of these features must be incorporated in a particular design, but avoiding them when possible will make for lower mold cost and a greater daily output per mold.

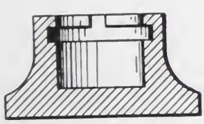
Don't design pieces like Figure A if Figure B will do.

Don't specify dimensions closer than .005″, plus or minus, unless really necessary.

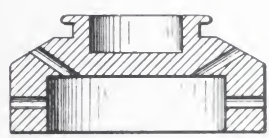
Don't overlook the fact that metal inserts may be securely imbedded during the molding operation, thus eliminating subsequent assembling. They should not be placed too near the edge of the object being molded.

When permissible, interior walls and cavities should be made with a slight draft, say .015″ per inch.

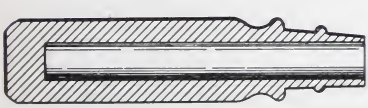
When lettering is required, it is easier and cheaper to engrave or sink the letters into the mold, so as to produce relief lettering on the molded piece. The opposite effect requires raised letters in the mold, which are expensive to make.



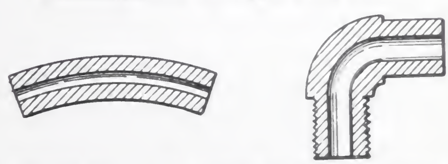
Interior Undercut



Horizontal or Oblique Side Holes



Thin Walled Barrel Pieces with Exterior Flanges



Right Angle or Curved Tubular Pieces

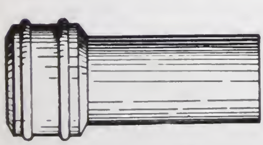


Fig. A

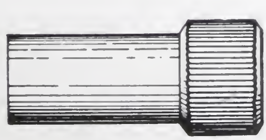
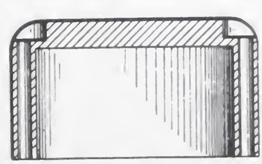


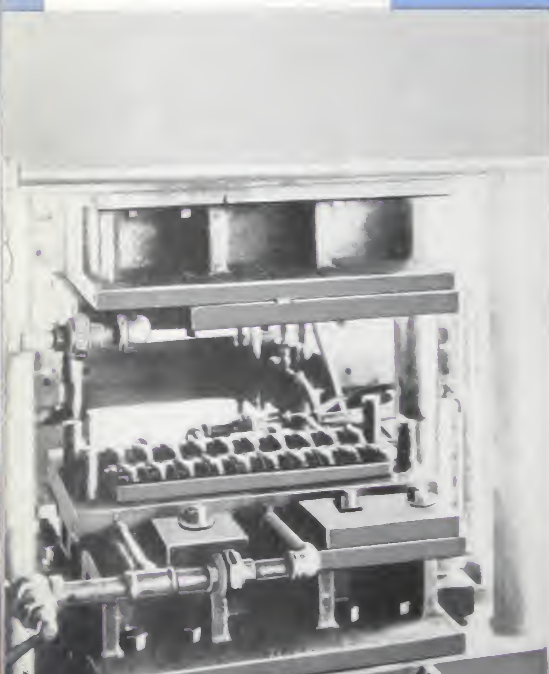
Fig. B



Long Perpendicular Holes with Thin Walls

Figure No. 19. Semi-automatic press with four-impression mold for producing "horse-shoe" base. All fine holes molded in single operation

● PRESSES



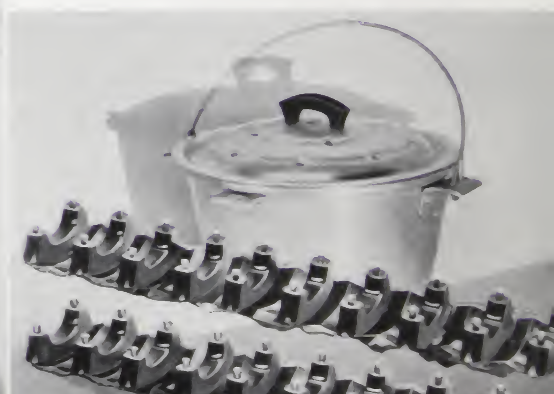


Figure No. 20. Semi-automatic press with twenty-impression mold for producing "dutch oven" handles. Metal inserts included in the molding operation

Engineering Service

Bakelite Sales Representatives are engineers first, salesmen afterwards. Benefiting from Bakelite Corporation's 26 years of experience in dealing with problems concerning Bakelite Molded, and seeing it used in so many different places and in so many different ways, these sales engineers are often able to suggest means of applying this material which would not be readily apparent to others. Consequently, they are as much consultants or advisers as salesmen.

The services of Bakelite Corporation's Engineering Staff and Research Laboratories are always at the disposal of those who wish aid in problems of correct design or other matters related to the adaptation of Bakelite molded to their special needs.

The purpose for which molded products are to be employed should be given. It should also be clearly stated what, if any, chemical action they must be capable of resisting; also what temperatures and what mechanical or electrical stresses they must bear. This information is needed in determining the grade of material best suited to the service required.

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BAKELITE VARNISHES. Coating and impregnating varnishes for electrical coils, windings, and for fabric and paper employed in the production of laminated products. Highly dielectric and heat-resisting. Impervious to oils, water, solvents and most chemicals. Hardened by baking.

BAKELITE ENAMELS. Opaque coatings to protect metal surfaces against corrosion and the action of chemicals. Because of good electrical properties, hardness, and resistance to heat, they are effective as insulating coverings for metal conductors. Baked, after application, at 120°C. (248°F.).

BAKELITE LACQUERS. Hard, transparent coatings for highly finished metal. Resist solvents, gases, water, and perspiration. Baked, after application, at 135°C. (275°F.) for twenty minutes.

BAKELITE CEMENTS. Technical cements for certain special applications. Extremely hard and tenacious; exceptionally resistant to heat, solvents and most chemicals. Require baking to harden them.

BAKELITE CAST RESINOID. Clear or translucent cast resinoid in a wide range of colors. Used for pipe bits, jewelry, and novelty goods. Odorless, tasteless, non-inflammable, hard, and strong.

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